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Interactive comment on "Development of an OMI AI data assimilation scheme for aerosol modeling over bright surfaces – a step toward direct radiance assimilation in the UV spectrum" *by* Jianglong Zhang et al.

Anonymous Referee #2

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This paper develops a data assimilation scheme using the VLIDORT radiative transfer model and simulated aerosol information from the NAAPS model to assimilate OMI AI measurements into the NAAPS model. Including the OMI AI assimilation improves the NAAPS simulation compared to the OMI AI, and improves NAAPS simulated AOD compared to AERONET AOD, but it does not outperform the NAAPS reanalysis AOD compared to AERONET. Overall the paper is well written and their data assimilation approach is well explained. I do have some comments.

My main issue with the paper is that the authors state in the abstract: "Improvements

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in model simulations demonstrate the utility of OMI AI data assimilation for improving the accuracy of aerosol model analysis over cloudy regions and bright surfaces." But this is not really shown anywhere in the paper.. On line 149 it is even stated: "As AERONET data require a cloud-free line of sight to the solar disk, the performance of OMI AI data assimilation over overcast regions is not evaluated." Yes there are AI measurements over cloudy regions and bright surfaces, but nowhere in the paper have the authors specifically evaluated the performance of their analysis over bright or cloudy surfaces compared to, say, the NAAPS reanalysis AOD from MODIS and MISR. The authors even state that their assimilation does not improve the NAAPS AOD compared to the reanalysis AOD, so where is the evidence of improvement over bright and cloudy surfaces? It is not explicitly stated which products from MODIS and MISR go into the NAAPS reanalysis, but both MODIS deep blue and MISR retrieve AOD quite accurately over bright surfaces, especially deserts, so this statement really should be backed up somehow.

Other comments:

- In section 4.3 Sensitivity Analysis, the authors discuss how varying smoke SSA affects the AI and conclude that there is a need for regionally varying SSA values for smoke to be included for future studies. However, the issue is not necessarily varying smoke SSA, it is the fact that the model used in this paper treats all "smoke" as one aerosol type with a single SSA value. In reality, "smoke" is composed of both black and organic (that is, brown) carbon, which have different SSA values, and different areas have different contributions of black and brown carbon to the overall "smoke". So really what the authors are showing is a major limitation in modelling absorbing aerosol with the particular model they chose.

- Also in section 4.3, the authors state: "Interestingly, although simulated AI values are significantly affected by perturbing SSA values as shown in Figure 6, less significant impacts are observed for NAAPS AOD." However, this is to be expected, because AOD is a measure of the total extinction due to the presence of aerosols, so changing the

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fraction that is either scattering or absorbing would not change the overall extinction.

- Lines 136-139: “Isolated high AI values are removed as follows. First, for a 4x4 pixel box, if the mean AI is less than 0.7 but an individual AI value is larger than 0.7, then that one value is removed. Second, if the standard deviation of AI values for a 3x3 pixel box surrounding a pixel is larger than 0.5, that individual AI value is likewise removed.” It is not explained how the authors came up with this criteria, and it might be helpful for them to include a bit of an explanation.

Technical comments:

- Lines 80-86 are worded a little confusingly: “AI retrievals are currently computed using observations from sensors with ozone-sensitive channels. For example, the Ozone Monitoring Instrument (OMI), Ozone Mapping and Profiler Suite (OMPS), TROPOspheric Monitoring Instrument (TROPOMI) and the future Plankton, Aerosol, Cloud and ocean Ecosystem (PACE) mission can detect UV-absorbing aerosol particles, such as black carbon laden smoke or iron-bearing dust, over bright surfaces, such as desert, snow and ice covered regions, and aerosol plumes above clouds (e.g. Torres et al., 2012; Yu et al., 2012; Alfaro-Contreras et al., 2014; 2016).” At first it is being discussed how AI retrievals use ozone sensitive channels, then the “for example” is talking about detecting absorbing aerosols.

- Line 276: dust “plums” should be “plumes”

- Line 453: “proving” should be “providing”

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